Buried Impact Craters in Utopia Planitia Basin Region, Mars

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Abstract

Using high-resolution polygon data from the Mars Orbiter Laser Altimeter (MOLA), located on the Mars Global Surveyor (MGS), the search for well preserved impact craters, 15 –100 km in diameter, is investigated in order to appreciate the concept of aging the Utopia Planitia Basin Region on Mars. MOLA are false-color topographic projections from different angles. The vertical accuracy of these projections is approximately less than 5 meters. The maps have a resolution of up to 300 dots per inch.

The area researched for the buried impact craters is between 40* and 60* N latitude belts and 240* to 300* W longitude. By using the MOLA polygon data and stretching the topographic shaded relief maps we can begin to visualize buried craters that may be very well preserved in some areas. In other areas we uncover only the remnant walls of an ancient crater, but remarkably still identifiable. These are called quasi-circular depressions (QCDs). A comparison to 1983 Viking Lander maps is the used to compare visible craters with those not so visible. The study will also demonstrate a difference in the relief, elevations, and slope area of the Basin. This will provide us with better equipped information on the crater bombardment era of Mars.

Hypothesis

Since there are approximately four more weeks of research, there is no final conclusion at this time. The proposed conclusion will be that by researching the Utopia Planitia Basin Region which envelopes an area of approximately 3000 km in diameter and 1-3 km in depth we can geologically estimate the approximate age of this region. With further study and a more detailed research of all craters under 15 km would give us a better understanding of the crater bombardment Mars experienced in its early beginnings. This will take much more time and dedication. We need to understand that by determining the age of the planet we also determine the sequence of bombardment the planet experienced and how the planet eventually cooled and finished forming.

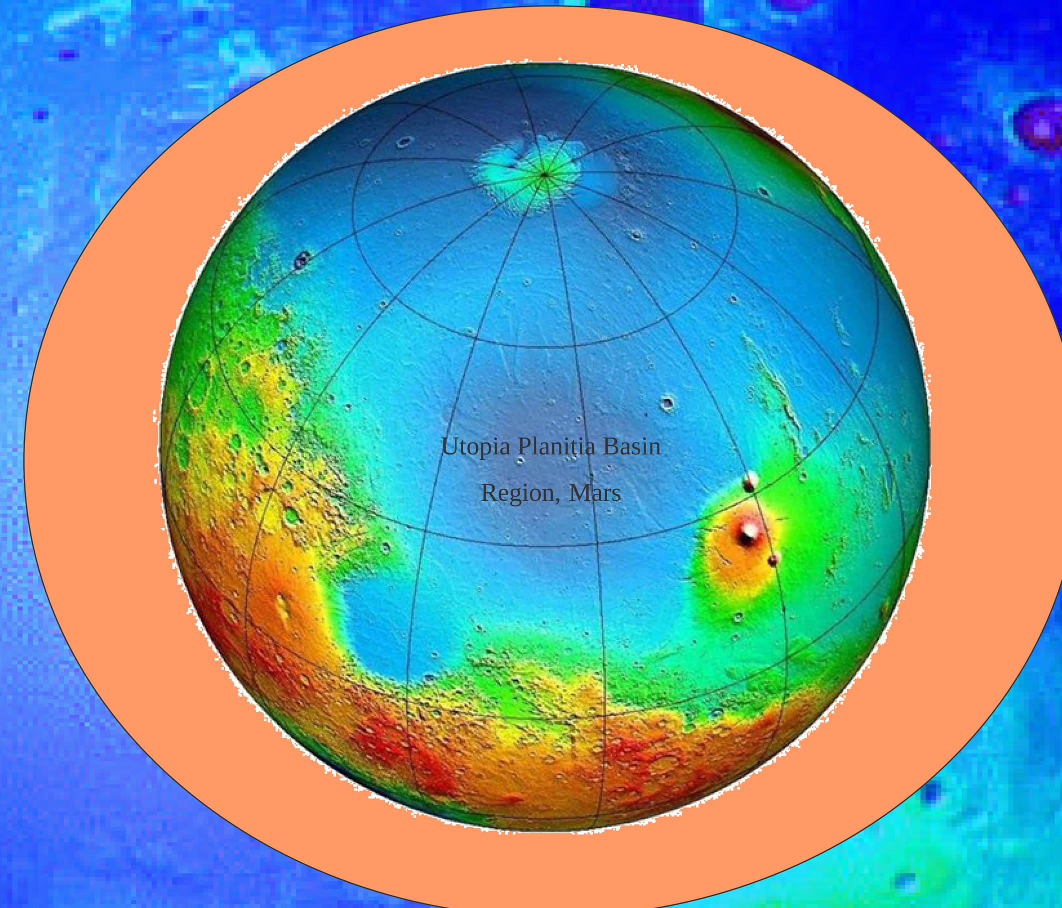
We can further study the actual Utopian Basin impact that occurred very early in the evolution of Mars, thus, the planet was still experiencing a very high temperature era. This would have caused a very thin and elastic lithosphere to very quickly compensate a shallow basin.

Objective

To determine the age of the planet Mars.

If we can determine the age of Mars, we can come closer to the origins of our own planet. We are missing a crucial billion years or so of our own geological history. We want to find this timeline on Mars. We want to locate any evidence that our origins had the same beginnings. We can easily see and measure the Southern cratered area of Mars. On the other hand, the Northern lowlands of Mars are just leaking out their secrets. Finding these buried craters can be extremely important to the aging process and formation of this Martian terrain. From aerial views, this region seems to be fairly flat and even, but upon closer examination, Mars reveals its past history. The scars of early planetary development are evident under the layers of lava flows and debris fields. Through the use of Viking Orbiter 2 data, the 1983 USGS maps, and the information captured by MOLA we are able to uncover many areas that have many craters of different depths, diameters, and ejecta types buried in the Utopia Planitia region which in itself may be a giant impact crater. As more buried impact craters are uncovered, the ejecta is also observed as not of an explosion or violent collision type, but one of a more viscous, moist, and/or liquid type eruption. For example: throwing a rock in a very watery muddy puddle, you would not have ejecta projectiles exploding into the atmosphere, but more of an ooze consistency. Therefore, some of this viscous surface may have managed to hide more craters because the craters did not scar the surface as deeply or violently. The type of ejecta “flow” is very different than the ejecta debris fields on the Moon or Mercury.

We can age Mars by counting a similarly crater impacted area of the moon. There are no other methods we can use at this time since we cannot retrieve samples and chemically age them in a laboratory. By using the impact ejecta rays and where they are placed on the surface of other impact ejecta rays, and how many impacts in themselves, we can calculate a similar area of the moon to age that area of Mars. Therefore, the number of craters on the moon is used as a benchmark for other cratered terrains.



Introduction: Viking

On Sept. 9, 1975, Viking 2 was launched. The Orbiter and Lander entered Mars orbit on Aug. 07, 1976. Utopia Planitia, which has a bearing at 47.97*N, 225.74*W, was the landing site for the Lander. The Orbiter imaged the entire planet at a resolution of 150m to 300m. Viking 2 Orbiter gave us Mars. With it we saw majestic volcanoes, vivid lava plains, huge craters, deep canyons, wind-formed structures and dreams of surface water. Mars is divided into two distinct areas. The Northern region which has low plain areas and a highly cratered South side. In the Equator region we have Valle Marineris, the longest and deepest canyon system known in our solar system.

In 1983, the United States Geological Survey (USGS) took the almost 16,000 images from the Orbiter and transferred the data to produce out first map quadrants of Mars.

Introduction: MGS

The Mars Global Surveyor (MGS) was launched on Nov. 07, 1996. MGS arrived to Mars and situated itself in orbit on Sept. 02, 1997. On it was the Mars Orbiter Laser Altimeter (MOLA). This is the instrument that will assist in the search for buried impact craters along with the Viking maps by USGS. MOLA, David Smith, Goddard Space Flight Center, combines the measurements of transmitted laser beams sent to Mars at 10 HZ, and calculates the time to reach and reflect off the surface. This measurement of time will give the approximate height of land surface features. With this combined information of approximately 900,000 measurements of elevation per day, a topographic map of Mars can be created. Its optical power is at 1064 nm.

MOLA has an elevation point accuracy of 42 ft or 13m. This instrument has made it possible to view the distinct contrast between the Northern Lowlands and the Cratered Southern areas of Mars. MOLA provides the high resolution necessary for the search of buried impact craters that can assist in aging the Northern lowlands of Mars. Will the answer permit us to evaluate a possible internal areological cycle in the early part of Martian evolutionary history.

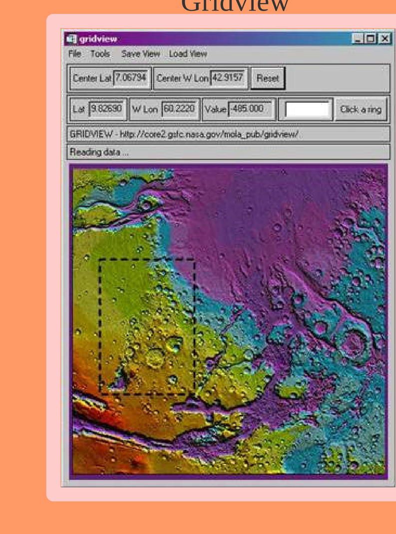
Gridview

Gridview is an Interactive Data Language (IDL) tool that was developed specifically to view the topographical data from MOLA and is used as a primary tool in locating buried impact craters of Mars. This tool will be used with a Viking map to account and discount crater images in the Utopia Planitia Basin Region, Mars. It gives valuable information about each grid viewed, especially the latitude, longitude, and elevation of that area. It can be used to rotate and zoom into specified areas of the planet. By stretching the color, more detailed viewing is accomplished and more deep impact craters and other features are visible. Contouring helps view the area of interest in its elevations. The profile tool can give an approximation of the depth and the diameter of the crater. This tool is also helpful when the area is suspect of more than one impact crater. With the profile tool you can also measure distance, height, and slope measurements. Postscript keeps the data you have uncovered with the use of the profiling tool and gives you a physical document to evidence the data. Shaded relief can change the Gridview from the maximum colorization to a grayscale shaded relief. Last but not least, the flybys are cool. Ghostscript is the name of a set of software that provides: An interpreter for the PostScript language and the PDF file format, A set of C procedures (the Ghostscript library) that implement the graphics capabilities that appear as primitive operations in the PostScript language. This information can let us visually inspect a cross-section view of the suspect crater. It can help differentiate between one crater and several composites in one local. It can assist in the diameter analysis of the measurements needed. The final outcome is similar to the example below.

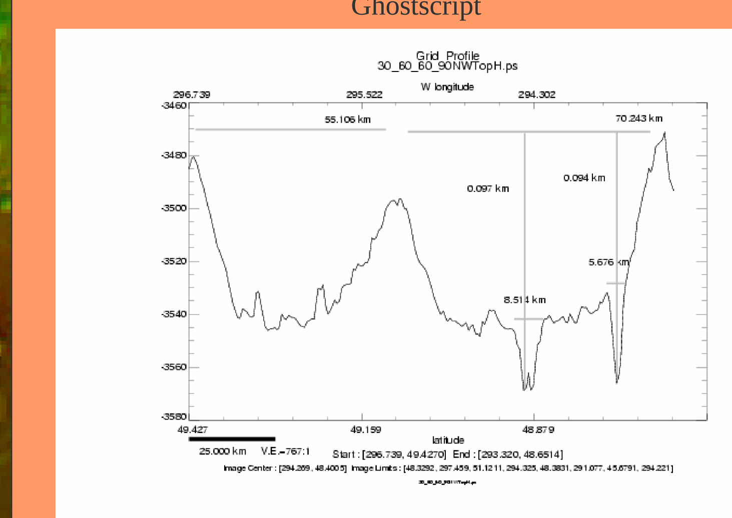
Gridview Tools

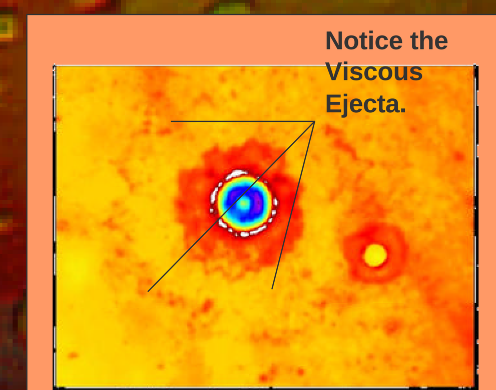
- Latitude / Longitude / Value (Elevation) Tracking
- Global Rotation and Zooming
- Color Stretching and Contouring
- Profiling
- Crater / Basin Measurement and Ploting
- Postscript and Image Output
- Distance / Height / Slope Measurement
- Shaded Relief View
- Overlay other Data Contours
- Area and Volume Calculation Tool
- Data fly through

Gridview



Ghostscript

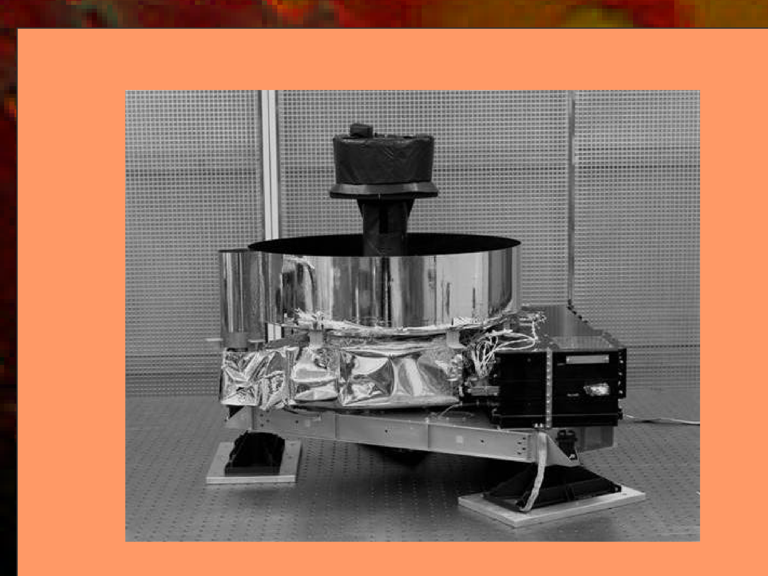




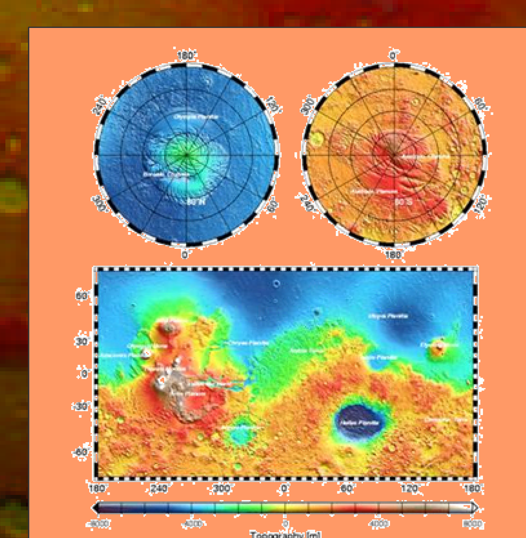
Progress

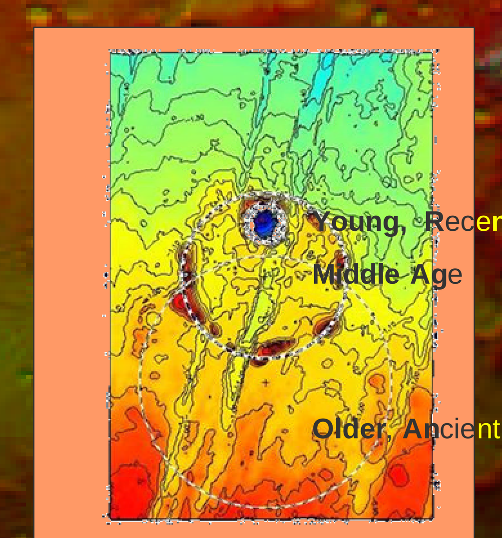
In order to complete the research assignment, approximately 9 – 10 quadrant maps must be researched. These are the approximate number of quadrants that encompass the Utopia Planitia Basin. A detailed report of crater data rings must be created and each crater must be visually eliminated by examination of the Viking USGS maps. There have been about 6 maps reviewed and there are still about 3 more to be completed. At the end of this 10 week research project, the complete area of the Utopia Planitia Basin should have been researched.

How many craters can you find in this picture?



Mars Orbiter Laser Altimeter





Acknowledgement

To My God, Parents, Husband: Antonio, Children: Anthoni, Cherokee, Whitehawk, and Travis, Grandchildren: Jazmine and Cheyenne

Academics

University of Texas - Pan American, Edinburg, Texas (Major: Criminal Justice)

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Texas A&M University - Kingsville, Kingsville, Texas (Graduation Date: 2005.05.05: B.S.: Geology)

References

Frey, Erin., Evidence for Buried Crust Older than the Oldest Observed Surface Units on Mars, Oct 2002 :
http://gsa.confex.com/gsa/2002AM/finalprogram/abstract_41753.htm

Frey, Herbert V., Age of Crustal Dichotomy on Mars Constrained by MOLA Data, April 2002 : http://denali.gsfc.nasa.gov/sci_hi/sci_hi_04_02/apr02c.html

Frey, Herbert V., Buried Basins on Mars, 2002 : http://denali.gsfc.nasa.gov/annual2002/AR02_REPORT.htm#buried

Ghostscript: AFPL Ghostscript: http://www.ghostscript.com/

Gridview: NASA: http://core2.gsfc.nasa.gov/gridview/

Mars Global Surveyor: NASA NSSDC: http://nssdc.gsfc.nasa.gov/planetary/marsurv.html

Mars Orbiter Laser Altimeter: NASA: http://itpwww.gsfc.nasa.gov/tharsis/mola.html

Solomon, Sean C., An Older Face for Mars, Nature/Vol418/4 July 2002/ Pg.. 27/ : www.nature.com/nature : http://itpwww.gsfc.nasa.gov/tharsis/solomon.nv.pdf

Viking Project Information: NASA NSSDA: http://nssdc.gsfc.nasa.gov/planetary/viking.html